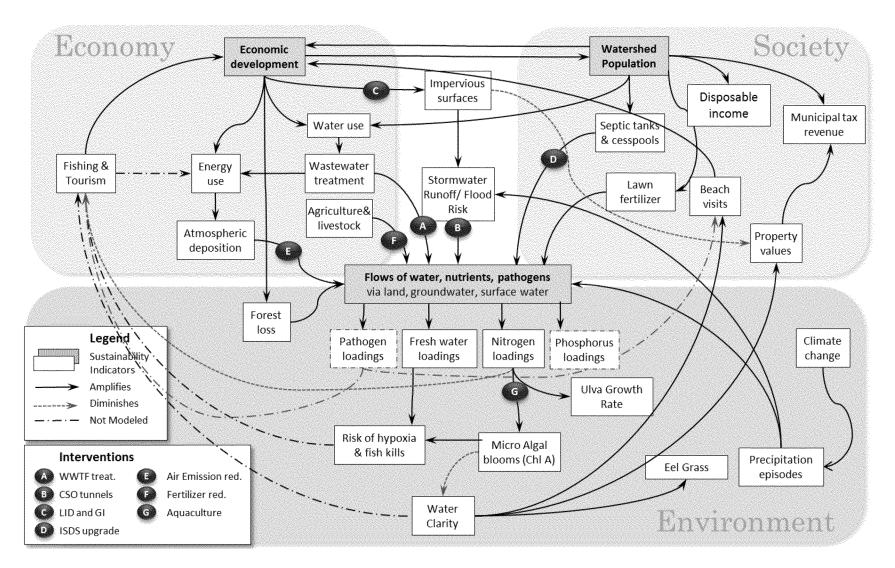# NARRAGANSETT 3VS MODEL OVERVIEW

In an effort to advance sustainability, EPA New England and the EPA Office of Research and Development (ORD) are collaborating on a project to address the problem of nutrient impairment in sensitive waterways. The project is based on the Triple Value (3V) model, an innovative approach that captures the dynamic interrelationships between economic, environmental, and social systems. This approach is being piloted in the Narragansett Bay watershed with the development of a policy simulation tool that draws from watershed-specific data and extensive stakeholder input.   The model, named Narragansett-3VS (Triple Value Simulation) enables users to explore different scenarios, interpret results and evaluate outcomes of policies or interventions aimed at reducing adverse nutrient impacts to the watershed. The model is based on an integrated assessment methodology called "system dynamics," and is intended to support strategic dialogue about alternative water resource management policies by serving as a communication tool that can help build shared understanding among diverse groups including technical experts, policy makers, and citizens.

The model schematic on the following page illustrates the 3VS framework of economy, society, and environment, including the primary variables included in the Narragansett 3VS model, as well as key relationships among them. The schematic shows the indicators and relationships included in the model (solid lines), as well as additional ones that have been identified as important elements of the system that the model represents, but could not be included in the model quantitatively (dashed lines). Black lines indicate amplifying causal relationships while red lines indicate diminishing causal relationships. Interventions are represented by green circles and situated on the targeted causal relationship.

The main elements of the schematic can be grouped into loadings (boxes with arrows pointing toward the grey box labeled "Flows of water, nutrients, pathogens via land, groundwater, surface water"), environmental relationships (boxes and arrows in the "Environment" section of the schematic), and impacts on economy and society (all other boxes and arrows).

Following the schematic, this document presents an outline of the scenario setting options and a list of the key output indicators available for the Narragansett 3VS model.

Economy

- Economic development
- Fishing & Tourism
- Energy use
- Atmospheric deposition
- Water use
- Wastewater treatment
- Agriculture & livestock
- Impervious surfaces
- Stormwater Runoff/ Flood Risk
- Forest loss

Society

- Watershed Population
- Disposable income
- Municipal tax revenue
- Septic tanks & cesspools
- Lawn fertilizer
- Beach visits
- Property values

Flows of water, nutrients, pathogens
via land, groundwater, surface water

- Pathogen loadings
- Fresh water loadings
- Nitrogen loadings
- Phosphorus loadings

Environment

- Climate change
- Ulva Growth Rate
- Risk of hypoxia & fish kills
- Micro Algal blooms (Chl A)
- Eel Grass
- Precipitation episodes
- Water Clarity

Legend

- ▭ Sustainability Indicators
- → Amplifies
- ----→ Diminishes
- —·—· Not Modeled

Interventions

- Ⓐ WWTF treat.
- Ⓑ CSO tunnels
- Ⓒ LID and GI
- Ⓓ ISDS upgrade
- Ⓔ Air Emission red.
- Ⓕ Fertilizer red.
- Ⓖ Aquaculture

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SCENARIO SETTING OPTIONS:

1) **Specify interventions:** Methods used to reduce N loadings, include specified reductions from:
   - Upgrades to Wastewater Treatment Facilities (WWTFs)
   - Upgrades to Independent Sewage Disposal Systems (ISDSs)
   - Reductions in nitrogen loading from animal waste
   - Reductions in nitrogen loading from agricultural fertilizer
   - Reductions in nitrogen loading from residential lawn fertilizer
   - Reductions in atmospheric deposition of nitrogen
   - Nitrogen reductions from aquaculture farms
   - Reductions in nitrogen loadings from surface water runoff through Low Impact Development/Green Infrastructure (LID/GI) – resulting in changes to effective impervious area

2) **Specify magnitude of impact for each intervention:** Magnitude of change in percent (e.g., 40% reduction in N loading, or 10 % reduction in impervious area)

3) **Specify timing of impact for each intervention:** Year at which change is achieved, can include interim targets (e.g., 5% reduction by 2020 and 20% reduction by 2030).

2) **Specify geographic location of impact for interventions:**
   - WWTF reductions, LID/GI, and residential fertilizer reductions can be specified by watershed loading area.
   - Aquaculture farms can be specified by location within the Bay.
   - All other interventions affect the entire watershed.

3) **Specify cost of N reduction for each intervention:**
   - Capital costs
   - Ongoing costs: dollars per kg of N reduced

4) **Specify percent of cost borne by government for each intervention:** percent publicly financed (as opposed to borne by citizens).

   - Specify interest rate and financing period for publicly financed interventions

KEY OUTPUT INDICATORS:

INDICATOR	UNITS	Scale
Economic/Social Indicators		
Total and per capita cost of N reduction	dollars/year	Varies by Intervention*
Total and per capita private N reduction costs	dollars/year	Varies by Intervention*
Total public N reduction costs	dollars/year	Varies by Intervention*
Total cost as percent of disposable income	%	Varies by Intervention*
Commercial finfish landings	dollars	Whole Bay
Aquaculture revenue	dollars	Whole Watershed
Employment in aquaculture	jobs	Disaggregated
Beach visits	# of visits	Disaggregated
Value of beach visits	dollars	Disaggregated
Property value change	dollars	Disaggregated
Change in municipal tax revenue	dollars	Whole Watershed
Environmental Indicators		
Total Nitrogen loadings	kg/year	Disaggregated
Nitrogen loadings by source category	kg/year	Disaggregated
Nitrogen concentration	mg/L	Disaggregated
Chlorophyll A	ug/L	Disaggregated
Water turbidity / clarity (secchi depth)	meters	Disaggregated
Ulva Growth Rate	%/day	Disaggregated
Eelgrass Improvement Potential	Unitless	Disaggregated
Hypoxia Risk	Unitless	Disaggregated